UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 28, 2023

Dr. Ayman I. Hawari, Director
Nuclear Reactor Program
Department of Nuclear Engineering
North Carolina State University
Campus Box 7909
2500 Stinson Drive
Raleigh, NC 27695-7909

SUBJECT: NORTH CAROLINA STATE UNIVERSITY –– ISSUANCE OF AMENDMENT NO. 20 TO RENEWED FACILITY OPERATING LICENSE NO. R-120 AND TECHNICAL SPECIFICATIONS FOR THE PULSTAR NUCLEAR RESEARCH REACTOR RE: FUELED EXPERIMENTS (EPID NO. L-2022-NFA-0004)

Dear Dr. Hawari:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment No. 20 to Renewed Facility Operating License No. R-120 for the North Carolina State University (NCSU) PULSTAR Nuclear Research Reactor. The amendment revises technical specifications (TSs) 1.2, “Definitions,” 3.5, “Radiation Monitoring Equipment,” 3.6, “Confinement and Main HVAC Systems,” 3.8, “Operations with Fueled Experiments,” 4.4, “Radiation Monitoring Equipment,” and license conditions (LCs) 2.B.(2) and 2.C.(2) in response to NCSU’s application dated April 18, 2022 (Agencywide Documents Access and Management System Accession No. ML22108A168), as supplemented by letters dated July 11, 2022 (ML22193A167), March 13, 2023 (ML23075A056), May 12, 2023 (ML23132A126), and June 20, 2023 (ML23171B001). The amendment revises the TSs and LCs to provide a single fission rate limit that applies to all fueled experiments; to allow NCSU to perform fueled experiments with plutonium, in addition to uranium-235; and to allow NCSU to perform vented fueled experiments. The amendment also makes other revisions related to fueled experiments, including revising the TS definition of “fueled experiment.”

A copy of the related safety evaluation is also enclosed. If you have any questions, please contact me at (301) 287-0583, or by email at Justin.Hudson@nrc.gov.

Sincerely,


Signed by Hudson, Justin
on 07/28/23

Justin C. Hudson, Project Manager
Non-Power Production and Utilization Facility
Licensing Branch
Division of Advanced Reactors and Non-Power
Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Docket No. 50-297
License No. R-120

Enclosures:
1. Amendment No. 20 to Renewed
Facility Operating License No. R-120
2. Safety Evaluation

cc w/enclosures: GovDelivery Subscribers

SUBJECT: NORTH CAROLINA STATE UNIVERSITY -– ISSUANCE OF AMENDMENT NO. 20 TO RENEWED FACILITY OPERATING LICENSE NO. R-120 FOR THE PULSTAR NUCLEAR RESEARCH REACTOR RE: FUELED EXPERIMENTS (EPID NO. L-2022-NFA-0004) DATED: JULY 28, 2023

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

NORTH CAROLINA STATE UNIVERSITY

DOCKET NO. 50-297

PULSTAR NUCLEAR RESEARCH REACTOR

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 20
License No. R-120

1. The U.S. Nuclear Regulatory Commission (NRC, the Commission) has found that:

   A. The application for amendment to Renewed Facility Operating License No. R-120, filed by the North Carolina State University (the licensee) on April 18, 2022, as supplemented on July 11, 2022, March 13, 2023, May 12, 2023, and June 20, 2023, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in Title 10 of the *Code of Federal Regulations* (10 CFR) Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance that (i) the activities authorized by this amendment can be conducted without endangering the health and safety of the public and (ii) such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public;

   E. The issuance of this amendment is in accordance with 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the Commission's regulations and all applicable requirements have been satisfied; and

   F. Prior notice of this amendment was not required by 10 CFR 2.105, "Notice of proposed action," and publication of a notice of issuance for this amendment is not required by 10 CFR 2.106, "Notice of issuance."

2. Accordingly, the license is amended as described in Attachment 1 to this license amendment and by changes to the Technical Specifications as indicated in Attachment 2. The following paragraphs of Renewed Facility Operating License No. R-120 are hereby amended to read as follows:

2.B.(2) Pursuant to the Act and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," to receive, possess, and use in connection with operation of the reactor up to 25 kilograms of contained uranium-235 enriched to less than 20 percent in the isotope uranium-235 in the form of reactor fuel; up to 20 grams of contained uranium-235 of any enrichment in the form of fission chambers; up to 20 grams of plutonium in the form of fission chambers; up to 35 grams of contained uranium-235 of any enrichment in the form of foils or for fueled experiments; up to 5 grams of plutonium for fueled experiments; up to 200 grams of plutonium-239 in the form of plutonium-beryllium neutron sources; and to possess, but not separate, such special nuclear material as may be produced by the operation of the facility.

2.C.(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 20, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

3. This license amendment is effective as of its date of issuance and shall be implemented within 30 days of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

Joshua M. Borromeo

Digitally signed by Joshua M. Borromeo
Date: 2023.07.28 15:03:59 -04'00'

Joshua M. Borromeo, Chief
Non-Power Production and Utilization Facility Licensing Branch
Division of Advanced Reactors and Non-Power Production and Utilization Facilities
Office of Nuclear Reactor Regulation

Attachments:
1. Changes to Renewed Facility Operating License No. R-120
2. Changes to Appendix A, "Technical Specifications"

Date of Issuance: July 28, 2023

ATTACHMENT 1 TO LICENSE AMENDMENT NO. 20

RENEWED FACILITY OPERATING LICENSE NO. R-120

DOCKET NO. 50-297

Replace the following pages of Renewed Facility Operating License No. R-120 with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Renewed Facility Operating License No. R-120

Remove	Insert
- 2 -	- 2-
- 3 -	- 3 -

H. The issuance of this license is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied; and

I. The receipt, possession, and use of the byproduct and special nuclear materials as authorized by this license will be in accordance with the Commission's regulations in 10 CFR Parts 30 and 70, including Sections 30.33, 70.23, and 70.31.

2. Facility License No. R-120 is hereby amended in its entirety to read as follows:

A. The license applies to the PULSTAR nuclear research reactor (the facility) owned by the NCSU. The facility is located on the campus in Raleigh, North Carolina, and is described in the licensee's application for renewal of the license dated August 19, 1988, as supplemented on January 2, April 17, and December 18, 1989; April 17 and July 18, 1990; January 25, 1991; November 30, 1992; September 15, 1995; and October 4, November 25, and December 30, 1996.

B. Subject to the conditions and requirements incorporated herein, the Commission hereby licenses the NCSU:

(1) Pursuant to Section 104c of the Act and 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," to possess, use, and operate the facility at the designated location in Raleigh, North Carolina, in accordance with the procedures and limitations set forth in this license;

(2) Pursuant to the Act and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," to receive, possess, and use in connection with operation of the reactor up to 25 kilograms of contained uranium-235 enriched to less than 20 percent in the isotope uranium-235 in the form of reactor fuel; up to 20 grams of contained uranium-235 of any enrichment in the form of fission chambers; up to 20 grams of plutonium in the form of fission chambers; up to 35 grams of contained uranium-235 of any enrichment in the form of foils or for fueled experiments; up to 5 grams of plutonium for fueled experiments; up to 200 grams of plutonium-239 in the form of plutonium-beryllium neutron sources; and to possess, but not separate, such special nuclear material as may be produced by the operation of the facility.

(3) Pursuant of the Act and 10 CFR Part 30, "Rules of General Applicability to Domestic Licensing of Byproduct Material," to possess, use, but not separate, except for byproduct material produced in non-fueled experiments, such byproduct material as may be produced by the operation of the facility.

C. This license shall be deemed to contain and is subject to the conditions specified in Parts 20, 30, 50, 51, 55, 70, and 73 of 10 CFR Chapter I, to all applicable provisions of the Act, and to the rules, regulations, and orders of the Commission now or hereafter in effect and to the additional conditions specified below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at steady-state power levels not to exceed 1000 kilowatts (thermal).

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 20, are hereby incorporated in the license. The licensee shall operate the facility in accordance with the Technical Specifications.

(3) Physical Security Plan

The licensee shall fully implement and maintain in effect all provisions of the Commission-approved physical security plan, including all amendments and revisions made pursuant to the authority of 10 CFR 50.90 and 10 CFR 50.54(p), which are part of the license. This plan, which contains information withheld from public disclosure under 10 CFR 2.790, is entitled “NCSU PULSTAR Physical Security Plan,” Revision 8, dated January 12, 1996.

D. This license is effective as of the date of issuance and shall expire 20 years from its date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Seymour H. Weiss, Director
Non-Power Reactors and Decommissioning
Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Enclosure:
Appendix A Technical
Specifications

Date of Issuance: April 30, 1997

ATTACHMENT 2 TO LICENSE AMENDMENT NO. 20

RENEWED FACILITY OPERATING LICENSE NO. R-120

DOCKET NO. 50-297

Replace the following pages of Appendix A, “Technical Specifications,” with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Technical Specifications

Remove	Insert
Cover Page	Cover Page
ii	ii
- 2 -	-2-
-19-	-19-
-20-	-20-
-21-	-21-
-22-	-22-
-26-	-26-
-27-	-27-
-28-	-28-
-29-	-29-
-35-	-35-
-36-	-36-
-37-	-37-

Appendix A

Technical Specifications for the

North Carolina State University

PULSTAR Reactor

Facility License No. R-120

Docket No. 50-297

Amendment No. 20

Date: July 28, 2023

FIGURES

TABLES

1.2.7 **Control Rod**: A control rod is a neutron absorbing blade having an in-line drive which is magnetically coupled and has SCRAM capability.

1.2.8 **Excess Reactivity**: Excess reactivity is that amount of reactivity that would exist if all control rods (and Shim Rod) were fully withdrawn from the point where the reactor is exactly critical (k_{eff}=1).

1.2.9 **Experiment**: Any operation, hardware, or target (excluding devices such as detectors, foils, etc.) that is designed to investigate non-routine reactor characteristics or that is intended for irradiation within the pool, on or in a beam tube or irradiation facility, and that is not rigidly secured to a core or shield structure so as to be a part of their design. Specific categories of experiments include:

a. **Tried Experiment**: Tried experiments are those experiments that have been previously performed in this reactor. Specifically, a tried experiment has similar size, shape, composition and location of an experiment previously approved and performed in the reactor.

b. **Secured Experiment**: A secured experiment is any experiment, experimental facility, or component of an experiment that is held in a stationary position relative to the reactor by mechanical means. The restraining forces must be substantially greater than those to which the experiment might be subjected by hydraulic, pneumatic, buoyant, or other forces which are normal to the operating environment of the experiment, or by forces which can arise as a result of credible malfunctions.

c. **Non-Secured Experiment**: A non-secured experiment is an experiment that does not meet the criteria for being a "secured" experiment.

d. **Movable Experiment**: A movable experiment is one where it is intended that all or part of the experiment may be moved in or near the core or into and out of the reactor while the reactor is operating.

e. **Fueled Experiment**: A fueled experiment is an experiment which irradiates fissile material. Fueled experiments exclude the following:
   i. Fissile material not subjected to neutron fluence
   ii. Detectors containing fissile material
   iii. Sealed sources
   iv. PULSTAR reactor fuel used in operation of the reactor.

1.2.10 **Experimental Facilities**: Experimental facilities are facilities used to perform experiments. They include beam tubes, thermal columns, void tanks, pneumatic transfer systems, in-core facilities at single-assembly positions, out-of-core irradiation facilities, and the bulk irradiation facility.

3.5 Radiation Monitoring Equipment

Applicability

This specification applies to the availability of radiation monitoring equipment which must be operating during reactor operation.

Objective

To assure that radiation monitoring equipment is available for evaluation of radiation conditions in restricted and unrestricted areas.

Specification

The reactor or vented fueled experiment shall not be operated nor shall irradiated fuel or irradiated fueled experiments that are not contained in a properly sealed and approved shipping container be moved within the reactor building unless the radiation monitoring equipment listed below and in Table 3.5-1 is operating.[(1)(2)(3)(7)]

a. Three fixed area monitors operating in the Reactor Building with their setpoints as listed in Table 3.5-1.[(1)(3)(4)]

b. Stack particulate and stack gas building exhaust monitors continuously sampling air in the facility exhaust stack with their setpoints as listed in Table 3.5-1.[(1)(3)(4)]

c. The Radiation Rack Recorder.[(5)]

d. Vented fueled experiment exhaust gas radiation monitor continuously monitoring the experiment exhaust gas.[(7)]

e. Vented fueled experiment flow rate monitor continuously monitoring the experiment exhaust gas flow.[(7)]

Table 3.5-1: Required Radiation Area Monitors

Monitor	Alert Setpoint	Alarm Setpoint
Control Room	≤ 2 mR/hr	≤ 5 mR/hr
Over-the-Pool	≤ 5 mR/hr	≤ 100 mR/hr
West Wall	≤ 5 mR/hr	≤ 100 mR/hr
Stack Gas	≤ 1000 Ar-41 AEC[(6)]	≤ 5,000 Ar-41AEC[(6)]
Stack Particulate	≤ 1000 Co-60 AEC[(6)]	≤ 5,000 Co-60 AEC[(6)]

[(1)] For periods of time, not to exceed ninety days, for maintenance to the radiation monitoring channel, the intent of this specification will be satisfied if one of the installed channels is replaced with a gamma-sensitive instrument which has its own alarm audible or observable in the control room. Refer to SAR Section 5.

(2) The Over-the-Pool Monitor may be bypassed for less than two minutes during return of a pneumatic capsule from the core to the unloading station or five minutes during removal of experiments from the reactor pool. Refer to SAR Section 5.

(3) Stack Gas and Particulate are based on the AEC quantities present in the ventilation flow stream as it exits the stack. Refer to SAR Section 10 for setpoint bases for the radiation monitoring equipment.

(4) May be bypassed for less than one minute immediately after starting the pneumatic blower system.

(5) During repair and/or maintenance of the recorder not to exceed 90 days, the specified area and effluent monitor readings shall be recorded manually at a nominal interval of 30 minutes when the reactor is not shutdown. Refer to SAR Section 5.

(6) Airborne Effluent Concentrations (AEC) values from 10 CFR Part 20 Appendix B, Table 2

(7) Monitors for vented fueled experiments are only required to be operating while the experiment is in operation.

Bases

A continued evaluation of the radiation levels within the Reactor Building will be made to assure the safety of personnel. This is accomplished by the area monitoring system of the type described in Section 5 of the Safety Analysis Report (SAR).

Evaluation of the continued discharge air to the environment will be made using the information recorded from the stack particulate and stack gas monitors.

When the radiation levels reach the alarm setpoint on any single area, or stack exhaust monitor, the building will be automatically placed in confinement as described in SAR Section 5.

To prevent unnecessary initiation of the evacuation confinement system during the return of a pneumatic capsule from the core to the unloading station or during removal of experiments from the reactor pool, the Over-the-Pool Monitor may be bypassed during the specified time interval. Refer to SAR Section 5.

Stack gas and stack particulate setpoints are based on the Notification of Unusual Event Emergency Action Level (EAL) for potential released nuclides including Ar-41, Co-60, and fission products. Fission product AEC values are higher than those for Ar-41 and Co-60. Therefore, using Ar-41 and Co-60 AEC for the setpoints is conservative.

3.6 Confinement and Main HVAC Systems

Applicability

This specification applies to the operation of the Reactor Building confinement and main HVAC systems.

Objective

The objective is to assure that the confinement system is in operation to mitigate the consequences of possible release of radioactive materials resulting from reactor operation.

Specification

The reactor shall not be operated nor shall irradiated fuel or irradiated fueled experiments that are not contained in a properly sealed and approved shipping container be moved within the reactor building unless the following equipment is operable, and conditions met:

Table 3.6-1: Required Main HVAC and Confinement Conditions

	Equipment/Condition	Function
a.	All doors, except the Control Room, and basement corridor entrance: self-latching, self-closing, closed and locked.	To maintain reactor building negative differential pressure (dp).(1)
b.	Control room and basement corridor entrance door: self-latching, self-closing and closed.	To maintain reactor building negative differential pressure.(2)
c.	Reactor Building under a negative differential pressure of not less than 0.2" H_2O with the normal ventilation system or 0.1" H_2O with one confinement fan operating.	To maintain reactor building negative differential pressure with reference to outside ambient.(3)
d.	Confinement system	Operable(4)(5)(7)
e.	Evacuation system	Operable(6)

(1) Doors may be opened by authorized personnel for less than five minutes for personnel and equipment transport provided audible and visual indications are available for the reactor operator to verify door status. Refer to SAR Section 5.

(2) Doors may be opened for periods of less than five minutes for personnel and equipment transport between corridor area and Reactor Building. Refer to SAR Section 5.

(3) During an interval not to exceed 30 minutes after a loss of dp is identified with Main HVAC operating, reactor operation may continue while the loss of dp is investigated and corrected. Refer to SAR Section 5.

(4) Operability also demonstrated with an auxiliary power source.

(5) One filter train may be out of service for the purpose of maintenance, repair, and/or surveillance for a period of time not to exceed 45 days. During the period of time in which one filter train is out of service, the standby filter train shall be verified to be operable every 24 hours if the reactor is operating with the Reactor Building in normal ventilation.

(6) The public address system can serve temporarily for the Reactor Building evacuation system during short periods of maintenance.

(7) When the radiation levels reach the alarm setpoint on any single area, or stack exhaust monitor, listed in Table 3.5-1, the building will be automatically placed in confinement as described in SAR Section 5.

Bases

In the event of a fission product release, the confinement initiation system will secure the normal ventilation fans and close the normal inlet and exhaust dampers. In confinement mode, a confinement system fan will: maintain a negative pressure in the Reactor Building and insure in-leakage only; purge the air from the building at a greatly reduced and controlled flow through charcoal and absolute filters; and control the discharge of all air through a 100 foot stack onsite. Section 5 of the SAR describes the confinement system sequence of operation.

The allowance for operation under a temporary loss of dp when in normal ventilation is based on the requirement of having the confinement system operable and therefore ready to respond in the unlikely event of an airborne release.

3.8 Operations with Fueled Experiments

Applicability

This specification applies to the operation of the reactor with any fueled experiment.

Objective

The objective is to prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure.

Specifications

Fueled experiments may be performed in experimental facilities of the reactor with the following conditions and limitations:

a. The fission rate for fueled experiments is limited to 2×10^9 fission/sec.

b. Specification 3.7 pertaining to reactor experiments shall be met with the exception that encapsulation is not required for vented fueled experiments, and vented fueled experiments may allow for the release of gaseous airborne activity. Vented fueled experiments shall be designed to prevent interaction with reactor components or pool water.

c. Each type of fueled experiment shall meet the following items:

   i. Meeting license requirements for the receipt, use, and storage of fissile material.

   ii. Physical form shall be solid or liquid.

   iii. Limiting the thermal power generated from the fissile material for experiments within the pool water to ensure that the surface temperature of the experiment does not exceed the saturation temperature of the reactor pool water.

   iv. Radiation monitoring for detection of released fission products at the exhaust of vented fueled experiments.

d. Credible failure of any fueled experiment shall not result in releases or exposures in excess of 10 percent of the annual limits established in 10 CFR Part 20.

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Bases

NUREG 1537 provides guidelines for the format and content of non-power reactor licensing. Guidelines on operating conditions and accident analysis for fueled experiments are given in NUREG 1537. These guidelines include (1) actuation of engineered safety features (ESF) to prevent or mitigate the consequences of damage to fission product barriers caused by overpower or loss of cooling events, (2) use of ESF to control of radioactive material released by accidents, (3) radiation monitoring of fission product effluent and accident releases, (4) accidental analysis for loss of cooling or other experimental malfunction resulting in liquefaction or volatilization of fissile materials, (5) accident analysis for catastrophic failure of the experiment in the reactor pool or air, (6) accident analysis for insertion of excess reactivity leading to fuel melting, and (7) emergency plan activation and classification.

The limitations given in Specification 3.8 ensure that (1) fueled experiments performed in experimental facilities at the reactor prevent damage to the reactor or excessive release of radioactive materials in the event of an experiment failure, (2) radiation doses to occupational personnel and the public and radioactive material releases are ALARA, (3) adequate radiation monitoring is in place, and (4) in the event of failure of a fueled experiment with the subsequent release of radioactive material, the resulting dose to personnel and the public at any location are well within limits set in 10 CFR Part 20.

Fueled experiments are reviewed, approved, and documented as required by Specifications 6.2.3 and 6.5. This includes (1) meeting license requirements for the receipt, use, and storage of fissile material, (2) limiting the amount of fissile material to ensure that experimental reactivity conditions are met and that radiation doses are well within 10 CFR Part 20 radiation dose limits following maximum fission product release from a failed experiment or vented release, and (3) limiting the thermal power generated from the fissile material to ensure that the surface temperature of the experiment does not exceed the saturation temperature of the reactor pool water.

4.4 Radiation Monitoring Equipment

Applicability

This specification applies to the surveillance requirements for the area and stack effluent radiation monitoring and vented fueled experiment exhaust gas radiation and flow monitoring equipment.

Objective

The objective is to assure that the radiation monitoring equipment is operable.

Specification

a. Channel calibration of the area and stack monitoring systems shall be performed annually but at intervals not to exceed fifteen (15) months or after replacement, repair, or modification of the monitoring system.

b. The setpoints of the area and stack monitoring systems shall be verified weekly, but at intervals not to exceed ten (10) days.

c. Channel calibration of the vented fueled experiment exhaust gas radiation and flow monitors shall be performed prior to initial operation of the experiment and annually, not to exceed fifteen (15) months, thereafter while the experiment is installed in the reactor or after replacement, repair, or modification of the monitoring system(s).

d. The setpoints of the vented fueled exhaust gas radiation and flow monitors shall be verified weekly, but at intervals not to exceed ten (10) days if the vented fueled experiment is installed in the reactor.

e. Channel checks shall be performed for the following:
   i. Area and stack radiation monitors prior to first start of reactor operation of the day.
   ii. Vented fueled experiment exhaust gas radiation monitor prior to first start of operation of the experiment of the day.
   iii. Vented fueled experiment flow rate monitor prior to first start of operation of the experiment of the day.

f. Channel tests shall be performed monthly, but at intervals not to exceed six (6) weeks, for the following:
   i. Area and stack radiation monitors.
   ii. Vented fueled experiment exhaust gas radiation monitor if the vented fueled experiment is installed in the reactor.
   iii. Vented fueled experiment flow rate monitor if the vented fueled experiment is installed in the reactor.

Bases

These systems provide continuous radiation monitoring of the Reactor Building with a check of readings performed prior to and during reactor operations. Weekly verification of the setpoints in conjunction with the channel checks, monthly channel tests, and annual calibration is adequate to identify long term variations in the system operating characteristics. Vented fueled experiments shall be considered installed in the reactor when they are placed in the experiment location and operable.

4.5 Confinement and Main HVAC System

Applicability

This specification applies to the surveillance requirements for the confinement and main HVAC systems.

Objective

The objective is to assure that the confinement system is operable.

Specification

a. The confinement and evacuation system shall be verified to be operable within seven (7) days prior to reactor operation.

b. Operability of the confinement system on auxiliary power will be checked monthly but at intervals not to exceed six (6) weeks.(1)

c. A visual inspection of the door seals and closures, dampers and gaskets of the confinement and ventilation systems shall be performed semi-annually but at intervals not to exceed seven and one-half (7½) months to verify they are operable.

d. The control room differential pressure (dp) gauges shall be calibrated annually but at intervals not to exceed fifteen (15) months.

e. The confinement filter train shall be tested biennially but at intervals not to exceed thirty (30) months and prior to reactor operation following confinement HEPA or carbon adsorber replacement. This testing shall include iodine adsorption, particulate removal efficiency and leak testing of the filter housing.(2)

f. The air flow rate in the confinement stack exhaust duct shall be determined annually but at intervals not to exceed fifteen (15) months. The air flow shall be not less than 600 CFM.

(1) Operation must be verified following modifications or repairs involving load changes to the auxiliary power source.

(2) Testing shall also be required following major maintenance of the filters or housing.

Bases

Surveillance of this equipment will verify that the confinement of the Reactor Building is maintained as described in Section 5 of the SAR.

4.6 Primary and Secondary Coolant

Applicability

This specification applies to the surveillance requirement for monitoring the radioactivity in the primary and secondary coolant.

Objective

The objective is to monitor the radioactivity in the pool water to verify the integrity of the fuel cladding and other reactor structural components. The secondary water analysis is used to confirm the boundary integrity of the primary heat exchanger.

Specification

a. The primary coolant shall be analyzed bi-weekly, but at intervals not to exceed eighteen (18) days. The analysis shall include gross beta/gamma counting of the dried residue of a one (1) liter sample or gamma spectroscopy of a liquid sample, neutron activation analysis (NAA) of an aliquot, and pH and resistivity measurements.

b. The secondary coolant shall be analyzed bi-weekly, but at intervals not to exceed eighteen (18) days. This analysis shall include gross beta/gamma counting of the dried residue of a one (1) liter sample or gamma spectroscopy of a liquid sample.

Bases

Radionuclide analysis of the pool water samples will allow detection of fuel clad failure, while neutron activation analysis will give corrosion data associated with primary system components in contact with the coolant. Refer to SAR Section 10. The detection of activation or fission products in the secondary coolant provides evidence of a primary heat exchanger leak. Refer to SAR Section 10.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 20 TO

RENEWED FACILITY OPERATING LICENSE NO. R-120

NORTH CAROLINA STATE UNIVERSITY

PULSTAR NUCLEAR RESEARCH REACTOR

DOCKET NO. 50-297

1.0 INTRODUCTION

By letter dated April 18, 2022 (Agencywide Documents Access and Management System Accession No. ML22108A168), as supplemented by letters dated July 11, 2022 (ML22193A167), March 13, 2023 (ML23075A056), May 12, 2023 (ML23132A126), and June 20, 2023 (ML23171B001), North Carolina State University (NCSU, the licensee) requested an amendment to Renewed Facility Operating License No. R-120 for the NCSU PULSTAR nuclear research reactor under the provisions of Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.90, "Application for amendment of license, construction permit, or early site permit." Specifically, the licensee requested to revise the facility's license conditions (LCs) and technical specifications (TSs) to provide a single fission rate limit that applies to all fueled experiments; to allow the licensee to perform fueled experiments with plutonium, in addition to uranium-235 (U-235); and to allow the licensee to perform vented fueled experiments. The licensee also requested to make other revisions related to fueled experiments, including revising the TS definition of "fueled experiment"; adding and revising requirements for radiation monitoring and ventilation; increasing the licensed possession limits for fissile materials to be used in fueled experiments; and revising other related fueled experiment requirements.

1.1 BACKGROUND

The NCSU PULSTAR nuclear research reactor is located in the Burlington Engineering Laboratory complex on the NCSU campus in Raleigh, North Carolina. The reactor, which was built by the American Machine and Foundry Company, is a heterogeneous light-water moderated and cooled, pool-type reactor that uses uranium dioxide fuel. NCSU is currently authorized to operate the reactor at a maximum steady-state thermal power level of 1.0 megawatt-thermal (MW(t)). The reactor was originally designed to be pulsed routinely to 2,200 MW(t) peak power; however, it is no longer licensed for pulse mode.

Chapter 10, “Experimental Facilities and Utilization,” of the NCSU updated safety analysis report (USAR), dated August 9, 2019 (ML19221B601), describes the experimental capabilities of the reactor. Section 10.1, “Summary Description,” describes the various experimental facilities at the reactor that may be used for neutron irradiation of experiments, including fueled experiments. These include rotating exposure ports/tubes, dry exposure ports/tubes, a pneumatic transfer system, and beam tubes. The exposure ports/tubes and pneumatic transfer system allow experiments to be in the highest thermal neutron flux positions nearest to the reactor core. When the rotating exposure ports are used, the experiment is completely submerged in the pool water. When the dry exposure ports, pneumatic transfer system, or beam tubes are used, the experiment is outside of the pool water, or is otherwise connected to the outside of the pool via a pathway that is not filled with water. The reactor does not currently have any in-core experimental facilities.

As part of its review of the license amendment request (LAR), the U.S. Nuclear Regulatory Commission (NRC, the Commission) staff conducted a regulatory audit from October 31, 2022, to July 28, 2023, in order to obtain information supporting its review. The NRC staff provided the regulatory audit plan by email dated October 31, 2022 (ML22304A184). The NRC staff conducted a site familiarization visit on December 20, 2022, which provided context to the type of experiments that the licensee plans to perform. The results of the NRC staff’s audit are documented in an audit report dated July 28, 2023 (ML23209A716).

In accordance with the current TS 3.8, “Operations with Fueled Experiments,” the licensee is permitted to conduct fueled experiments involving the irradiation of U-235. The current TS 3.8 restricts the mass and irradiation time to limit the fission products produced in an experiment, and to ensure that the dose consequences from an experiment failure and release of the entire inventory of fission products would not exceed 10 percent of the annual dose limits in 10 CFR Part 20, “Standards for Protection against Radiation.” The current TS 3.8 time and mass limits are based on a fueled experiment being exposed to a neutron flux of 1×10^{13} per square centimeter per second ($cm^2 \cdot s^{-1}$). As discussed in USAR section 10.2, “Experimental Facilities,” the thermal neutron flux in irradiation locations adjacent to the reactor core (i.e., the thermal flux when the exposure ports/tubes or pneumatic transfer system is used) is approximately 1×10^{13} $cm^2 \cdot s^{-1}$.

The current TS 1.2.9, “Experiment,” specification e, “Fueled Experiment,” defines a fueled experiment as any experiment which contains fissionable material. Also, as discussed in the NRC staff’s safety evaluation (SE) for License Amendment No. 17 (ML081480415), TS 3.8 limits the fissionable materials that may be used in fueled experiments to U-235.

The licensee proposed changes to TS 3.8 that would limit the fueled experiment fission rate to 2×10^9 fissions per second. This change would allow the licensee to control sample mass and neutron flux so that the fission rate will remain below 2×10^9 fissions per second. In the LAR, the licensee described two different types of fueled experiments: vented fueled experiments and encapsulated fueled experiments. The licensee stated that vented fueled experiments are experiments that allow off-gas of fission products into a filtered ventilation system. The release of fission products from the vented fueled experiments is the driving factor for the reduction in fission rate. During the NRC staff’s audit, the licensee showed the NRC staff the location of where the vented fueled experiments would be conducted. The licensee indicated that there is only one beam tube available for vented fueled experiments, which limits the facility to conducting only one vented fueled experiment at a time. The experimental facility would be housed in a shielding cave with the vent lines going through the shielding and out to the stack. However, the licensee plans on using gas-flow and radiation monitors for the vented fueled

experiments that are not credited in the analysis performed later in this SE. These radiation and flow monitors will add an additional level of safety for the vented fueled experiments. The licensee plans on using filters that will drive down the dose even further to minimize the amount of radiation released up the stack. In its supplement dated March 13, 2023, the licensee stated that the vented fueled experiments would be restricted to just gaseous releases, not particulate, ensuring that doses are kept minimal. In the event of an unusual release, particulate or gaseous, the radiation monitors would signal to the operators that there is an unexpected release and would isolate the vented fueled experiment from the stack. The licensee does not credit these safety functions in calculating the amount of radiation that would be released during normal operation, or in the event of an accident.

In the LAR, the licensee stated that encapsulated fueled experiments would be sealed in a container that will not release fission products during irradiation. The current TS 3.8 already permits the irradiation of encapsulated fueled experiments at varying fluxes and masses of U-235. The LAR would limit the fission rate for the encapsulated experiment, instead of limiting it to specific masses and fluxes as is done by the current TS 3.8 and would allow for plutonium to be irradiated.

2.0 REGULATORY EVALUATION

The NRC staff considered the following applicable regulatory requirements and guidance during its review of the proposed changes:

- Part 20 of 10 CFR, which establishes standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the NRC.

- Section 50.92, “Issuance of amendment,” of 10 CFR, which states, in part, that in determining whether an amendment to a license will be issued, the Commission will be guided by the considerations which govern the issuance of initial licenses to the extent applicable and appropriate.

- Part 70, “Domestic Licensing of Special Nuclear Material,” of 10 CFR, which provides for the licensing of special nuclear material (SNM).

- Part 73, “Physical Protection of Plants and Materials,” of 10 CFR, which provides the security requirements for SNM.

- NUREG-1537, Part 1, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content” (ML042430055), which provides guidance on the format and content of non-power reactor licensing applications.

- NUREG-1537, Part 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria” (ML042430048), which provides guidance on the conduct of NRC licensing reviews of non-power reactor licensing applications.

- NUREG-2387, “Credible Accident Analyses for TRIGA and TRIGA-Fueled Reactors” (ML083660125), which provides guidance for conducting accident analysis calculations for research reactors using TRIGA fuel.

- Regulatory Guide (RG) 2.2, “Development of Technical Specifications for Experiments in Research Reactors” (ML003740125), which provides guidance for developing TSs for experiments at research reactors.

- American National Standards Institute/American Nuclear Society (ANSI/ANS)-15.1-2007, “The Development of Technical Specifications for Research Reactors.”

3.0 TECHNICAL EVALUATION

3.1 Vented Fueled Experiments

3.1.1 Overview

In its LAR, the licensee described proposed vented fueled experiments at NCSU as consisting of the sample, which will be a fine layer of fissile material open to irradiation, connected to discharge piping that will have filters, flowrate and radiation monitors, and then connect to the building stack to dilute and discharge effluents up the stack. During the irradiation, the fission products will be released into the discharge piping, filtered, and monitored, and then pass into the building ventilation system that will discharge the effluents up the stack.

The licensee also stated that the vented fueled experiments will be in a beam tube. The flow rate and radiation monitoring systems to be installed on the system will help experimenters and reactor operators monitor the fission products coming from the vented fueled experiments. This will allow for actions to be taken if any unusual activity is detected on the radiation monitors. These radiation and flow rate monitors will be required by the proposed TSs. The air monitoring and analysis of air samples are performed at frequencies as required by the TSs and facility procedures which will provide sufficient time to halt or alter abnormal releases thereby ensuring compliance with the TSs and 10 CFR Part 20. The licensee further stated that leak testing will be performed and that leaks can be detected by continuous air monitors and radiation area monitors that are posted around the reactor bay. In its supplement dated March 13, 2023, the licensee provided calculations for an accident scenario where a leak goes undetected for eight hours, as discussed in section 3.1.2 below.

3.1.2 Licensee Calculations for Vented Fueled Experiments

In its supplement dated July 11, 2022, the licensee provided calculations for routine release and an eight-hour release accident scenario for vented fueled experiments. In its supplement dated March 13, 2023, the licensee provided corrections to its calculations and described additional background information.

The licensee performed calculations for an experiment that had 1,000 micrograms of fissionable material irradiated at a thermal neutron flux of $1x10^{12}$ neutrons/$cm^2 \cdot s^{-1}$ (the licensee also accounted for a 30 percent non-thermal flux) for 500 hours. The resulting fission rate from the vented fueled experiment in this example does not reach the maximum fission rate of $2x10^9$ fissions per second. The licensee calculated the atmospheric dispersion factor, X/Q, in its LAR. The licensee calculated different dispersion times ranging from two hours to over 96 hours. For continual operation with a vented fueled experiment, the licensee used the dispersion time of greater than 96 hours. The licensee used fairly calm atmospheric conditions using Pasquill Gifford Stability classes C, D, and F and using windspeeds between 1 to 2 meters per second. The licensee further analyzed different occupied locations around the reactor building to

determine the maximum X/Q value, which was determined to be $9.15x10^{-5}$ seconds per meters cubed (s/m^3).

In its supplement dated March 13, 2023, the licensee showed how it calculated an estimate of the annual release dose from vented fueled experiments. The licensee took into consideration a non-thermal flux factor, experiment flow rate, experiment exhaust volume, normal ventilation exhaust rate, and the reactor building free air volume. The licensee then calculated the activity of the fission products being released from the stack then converted it to a dose resulting in a release dose of 0.003 millirem (mrem). The result is reproduced in table 3.1, column three below.

The licensee also provided a calculation to show the expected dose increase from vented fueled experiments. The licensee calculated the predicted annual release for all activities to be 1.233 mrem (column four in table 3.1), using the maximum release from the building from 2018-2022, 1.230 mrem (column one in table 3.1), and adding the dose from the estimated release due to vented fueled experiments, 0.003 mrem (column three in table 3.1).

Table 3.1: Estimated Annual Releases from Vented Fueled Experiments

Maximum Release Levels from Facility (2018-2022)	Average Release Levels from Facility (2018-2022)	Estimated Release from Vented Irradiation	Predicted Total Annual Release (Maximum Facility + Estimated Vented Irradiation)
1.230 mrem	0.860 mrem	0.003 mrem	1.233 mrem

In its supplement dated March 13, 2023, the licensee calculated an estimated release for an accident scenario where a hypothetical break in the ventilation line on the vented fueled experiment leaks fission gases into the reactor bay rather than exiting through the stack. The licensee analyzed this accident taking into consideration: an eight-hour exposure for all reactor personnel and the public, 30 percent non-thermal flux, experiment flow rate, normal ventilation exhaust, experiment exhaust volume, and a dose dilution factor for fumigation conditions. For the occupational exposure, the licensee calculated the activity for each nuclide from the vented fueled experiment. The licensee also calculated the total effective dose equivalent (TEDE) by multiplying the activity of each nuclide by a dose conversion factor. Finally, the licensee summed the TEDE for each nuclide to get a total dose from all the nuclides to be $7x10^{-4}$ mrem.

For the public expose doses, the licensee calculated the TEDE using the activity for the occupational exposure calculation. The licensee calculated the TEDE by multiplying the activity by the dose conversion factor, the dilution factor for fumigation conditions, and the flow from the experiment to yield a dose of $6x10^{-6}$ mrem. The licensee also made dose adjustments for dispersion. The results of these calculations are reproduced in table 3.2 below.

Table 3.2: Accident Release Exposures for Occupational Workers and the Public for Vented Fueled Experiments

Accident Release for Vented Experiment Occupational Exposure	Accident Release for Vented Experiment Public Exposure
$7x10^{-4}$ mrem	$6x10^{-6}$ mrem

3.1.3 Analysis for Vented Fueled Experiments

Upon its review, the NRC staff finds that for vented fueled experiments, the licensee's calculated doses for annual and accident releases for workers and members of the public are below the applicable limits in 10 CFR Part 20 and that dose will not be expected to exceed 10 mrem per year from emissions. The NRC staff also finds that the methodology used by the licensee to calculate the annual release doses and the accident doses for vented fueled experiments is appropriate in depth and in accuracy. Moreover, the assumptions and conditions used in these calculations are conservative because the conditions set for the dispersion to the public are based on calm conditions, no operator actions were credited, no filtration was credited, and the radiation monitors for the vented fueled experiments were not credited. The NRC staff finds that the calculation performed by the licensee is appropriate for the proposed experimental apparatus, since the licensee did not credit several safety devices in the experimental apparatus or operator intervention. Therefore, the NRC staff concludes that the calculations performed by the licensee for vented fueled experiments are acceptable and that their results comply with NRC regulations.

3.2 Encapsulated Fueled Experiments

3.2.1 Overview

Under current TS 3.8, the licensee is permitted to conduct encapsulated fueled experiments using U-235. In its supplement dated May 12, 2023, the licensee requested to irradiate plutonium experiments in addition to the already-approved U-235 encapsulated fueled experiments. As described in its LAR, encapsulated fueled experiments are fueled experiments sealed in a container that will not allow fission products to escape.

3.2.2 Licensee Calculations for Encapsulated Fueled Experiments

In its supplement dated March 13, 2023, the licensee provided a dose calculation for an accident scenario involving an encapsulated fueled experiment, specifically, an irradiation of 35 grams of fissile material in the PULSTAR's neutron beams with a thermal flux on the order of $1x10^7$ neutrons/$cm^2 \cdot s^{-1}$. For this calculation, the licensee assumed: that the encapsulation of the fueled experiment completely fails and releases the saturated fission product inventory into the reactor building; that the contents of the experiment are evacuated out of the reactor building over 24 hours, with time averaged decay in the building; that the reactor personnel evacuate the building within six minutes; and that the neutron flux for the experiment was $1x10^7$ n/$cm^2 \cdot s^{-1}$ and included an additional 30 percent epithermal flux factor. The licensee calculated both the occupational and public doses.

For the occupational dose, the licensee calculated the activity of the saturated experiment and the particle density using the free air volume of the reactor building. The licensee calculated the TEDEs for each nuclide and summed them to yield a dose of 1.7 mrem.

For the public dose, the licensee calculated the time average activity which includes the removal rate from the reactor building over the 24 hours. From that activity, the licensee calculated the TEDE for each nuclide by multiplying: the activity, dilution factor, and dose conversion constant. The licensee summed the TEDEs for each nuclide to yield a dose of 0.09 mrem. The results from both the public and the occupational doses are reproduced in table 3.3 below.

Table 3.3: Accident Release Exposures for Occupational Workers and the Public for Encapsulated Fueled Experiments

Accident Release from Encapsulated Experiment Occupational Exposure	Accident Release from Encapsulated Experiment Public Exposure
1.7 mrem	0.09 mrem

3.2.3 Analysis for Encapsulated Fueled Experiments

Upon its review, the NRC staff finds that for encapsulated fueled experiments, the licensee's calculated accident dose releases for both the public and workers are within the applicable limits in 10 CFR Part 20, which states that the public dose limit is 100 mrem and that the occupational dose limit is 5,000 mrem. The NRC staff also finds that the dose release to the public is within the as low as reasonably achievable (ALARA) constraint of 10 CFR 20.1101, "Radiation protection programs," which states that the highest dose will not be expected to exceed 10 mrem per year from emissions. The NRC staff finds that the method used by the licensee to calculate the doses is acceptable because the failure mode of the encapsulated experiment is conservative due to the sealed experiment releasing its entire contents and spreading over the entire reactor building. The NRC staff also finds that the assumptions made by the licensee are acceptable because no operator action or intervention to prevent the release to members of the public, that the fission product inventory is fully saturated in the release, that the contents of the fueled experiment are spread equally across the reactor building, and the time decay release to the public for 24 hours are all conservative assumptions. Therefore, the NRC staff concludes that the calculations performed by the licensee are acceptable for encapsulated fueled experiments, which are similar to other reactor facilities that perform these types of experiments, and that their results comply with NRC regulations.

3.3 NRC Staff Confirmatory Calculations

The NRC staff performed confirmatory calculations to verify the licensee's calculations on releases from vented and encapsulated fueled experiments.

3.3.1 Bounding Accident Scenario

The NRC staff performed a confirmatory calculation that bounds releases from both vented and encapsulated fueled experiments. The NRC staff made several conservative assumptions for this calculation. The first assumption was that the fueled experiment has reached fission product saturation. Fission product saturation was based on the fission rate, which was set at the proposed TS limit of $2x10^9$ fissions per second. The second assumption was that the fission yield was entirely thermal fission. The third assumption was that all the full range of fission product inventory was released, including some short-lived nuclides that the licensee did not include, and the public and the radiation workers were exposed to the entire fission product inventory. The fourth assumption was that there was no decay time for the fission products or any filtration. The time frame was based on the evacuation times set by the licensee, however, in the public dose calculation, the exposure time canceled out, which resulted in a dose estimate from the entire fission product activity. The NRC staff also did not make any building geometry corrections for worker doses unlike the licensee. The last assumption was a X/Q value, which dictates the dilution factors of the release, of 0.01 s/m^3, as specified in NUREG-2387 as extremely conservative.

The NRC staff analyzed the two types of fissile materials being proposed for these fueled experiments, U-235 and plutonium-239 (Pu-239). For the calculation, the saturated inventories were determined through the fission yields and were converted to becquerels using the half-lives of each fission product. The release of the fission products was assumed to be uniform, across the entire reactor bay. A concentration of each fission product in the building air was calculated by dividing the saturation inventories by the reactor bay building volume.

Internal and external doses were calculated for members of the public and the radiation workers in the reactor bay. Stay times used in the calculation were derived from the licensee's explanation of stay times within the reactor bay area for workers and the time to evacuate members of the public from the site boundary: six minutes and 24 hours, respectively. The internal doses were calculated by multiplying: an average breathing rate, the concentration of the fission products in the air, stay time, atmospheric dilution (for members of the public), and a dose conversion constant that converts units of becquerels to mrem. The external dose was calculated by multiplying: the stay time, dose conversion factor, and the concentration of the fission products in the air. The TEDE was calculated by adding the internal dose to the external dose. The results are shown below in tables 3.4 for U-235 and 3.5 for Pu-239.

Table 3.4 NRC Staff Confirmatory Calculation Doses from Fueled Experiment Failure for Uranium-235

Location	NRC Staff Calculation for Total Effective Dose Equivalent (mrem)	Licensee Calculation for Vented Fueled Experiment (mrem)	Licensee Calculation for Encapsulated Fueled Experiment (mrem)	10 CFR Part 20 Limits (mrem)
Members of the Public	15.0	$6x10^{-6}$	0.09	100
Radiation Worker	239.5	$7x10^{-4}$	1.7	5,000

Table 3.5 NRC Staff Confirmatory Calculation Doses from Fueled Experiment Failure for Plutonium-239

Location	NRC Staff Calculation for Total Effective Dose Equivalent (mrem)	Licensee Calculation for Vented Fueled Experiment (mrem)	Licensee Calculation for Encapsulated Fueled Experiment (mrem)	10 CFR Part 20 Limits (mrem)
Member of the Public	9.6	$6x10^{-6}$	0.09	100
Radiation Worker	153.7	$7x10^{-4}$	1.7	5,000

The doses calculated by the NRC staff are higher than the doses calculated by the licensee. The NRC staff included isotopes such as strontium-90, at full saturation, which would not be realistically possible. The NRC staff also used the proposed TS 3.8 maximum fission rate and assumed that every fission in the fission rate was a thermal fission, which would result in an overall larger fission product inventory and is also not realistic. In addition, the NRC staff did not account for building geometry, decay, or dispersion, and used a larger atmospheric dispersion

factor. The NRC staff purposefully took a conservative approach to these calculations to show the low risk that these experiments would pose to workers and the public, which, in all cases, would be less than the limits in 10 CFR Part 20.

3.3.2 Continual Operation with a Vented Fueled Experiment

The NRC staff also performed a confirmatory calculation to verify the exposure to a member of the public from the constant off-gassing of fission product gases from vented fueled experiments. In this calculation, the NRC staff conservatively assumed that there is no filtration, the proposed TS 3.8 fission rate was used, all fissions were counted as thermal, that the fission product inventories were saturated, and that particulates are retained and not released. The NRC staff did not account for decay time for fission product gases that would not have decayed before leaving the building but did account for fission products with small half-lives that would have decayed before leaving the building.

The NRC staff used an atmospheric dispersion factor, X/Q, of 1.0×10^{-4} s/m^3. The NRC staff found this X/Q value of 1.0×10^{-4} s/m^3 to be a conservative representation of the variability of the air conditions around the reactor building for extended routine releases based on the licensee's X/Q calculation. As described in section 3.1.2 of this SE, the licensee's X/Q calculation assumes stable atmospheric conditions around the reactor facility which will lead to less dilution. The NRC staff added another margin of safety by increasing the X/Q factor from 9.15×10^{-5} s/m^3 to 1.0×10^{-4} s/m^3 further making the NRC staff's confirmatory calculation conservative for extended release. The NRC staff did not use the X/Q value of 0.01 s/m^3 provided in NUREG-2387 because it was determined to be too conservative for an extended release such as an annual release from continuous operation.

The time that was used in the calculation for the vented fueled experiment to off-gas was one year. One year was used to account for the maximum time that the licensee could technically operate a vented fueled experiment. This is a conservative overestimation because the licensee does not operate the reactor continuously. For this calculation, the stay time conservatively assumed that a member of the public stands at the site boundary for one full year, continuously. In the calculation, the NRC staff removed some isotopes with short lived half-lives that would not make it to the public due to decay. The exposure calculation takes the saturated fission product inventory of fission product gases and multiplies it by the stay time, the atmospheric dispersion factor, and the dose conversion factor. The NRC staff calculated results are provided in table 3.6 below.

Table 3.6 Dose to a Member of the Public after One Year of Vented Fueled Experiment Irradiation

Isotope	NRC Staff Calculated Dose (mrem)	Licensee Calculated Dose (mrem)	10 CFR Part 20 ALARA Constraint (mrem)
uranium-235	3.22	0.003	10
plutonium-239	2.79	0.003	10

The difference between the NRC staff calculated dose compared to the licensee calculated dose comes from the differences in assumptions, with the NRC staff's assumptions being significantly more conservative and bounding. The NRC staff assumed that the vented fueled experiment was operated for the entire year, 8,760 hours, compared to the licensee taking a

more realistic time frame of 500 hours. The NRC staff also used the proposed TS 3.8 maximum fission rate, which yielded a larger fission product inventory than the licensee's calculation. Another difference is the atmospheric dispersion factor, X/Q, where the licensee used a more realistic value of 9.15×10^{-5} s/m^3 compared to the slightly larger value that the NRC staff used of 1.0×10^{-4} s/m^3. Even with these conservative assumptions, the NRC staff determined that the calculated doses are within the 10 CFR Part 20 ALARA constraint.

3.4 Proposed License Condition Changes

Changes discussed in this section use the following format: a strikethrough indicates a deletion from the license condition and an underline indicates an addition to the license condition.

LC 2.B.(2)

> Pursuant to the Act and 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," to receive, possess, and use in connection with operation of the reactor up to 25 kilograms of contained uranium-235 enriched to less than 20 percent in the isotope uranium-235 in the form of reactor fuel; up to 20 grams of contained uranium-235 of any enrichment in the form of fission chambers; up to 20 grams of plutonium in the form of fission chambers; up to 35 grams of contained uranium-235 of any enrichment in the form of foils or for fueled experiments; up to 5 grams of plutonium for fueled experiments; ~~up to 2 grams of contained Uranium-235 of any enrichment in the form of foils;~~ up to 200 grams of plutonium-239 in the form of plutonium-beryllium neutron sources; and to possess, but not separate, such special nuclear material as may be produced by the operation of the facility.

The proposed change to LC 2.B.(2) would increase the quantity of U-235 for fueled experiments to 35 grams and would add the condition that would allow the licensee to have up to 20 grams of plutonium for fission chambers and up to 5 grams of plutonium for fueled experiments. The licensee stated in its supplement dated May 12, 2023, that the request to add 35 grams of uranium and 5 grams of plutonium would allow for the expected experiments that arise at the reactor. The licensee also stated that the change request to add 20 grams of plutonium for fission chambers would allow the licensee to support different measurement needs for experiments. This would include the fission chambers that are in service and ones that are in storage.

The NRC staff discussed with the licensee during the audit that the purposes for these new plutonium fission chambers are to support reactor operations and fueled experiment operations, but not to be a fueled experiment. The NRC staff notes that the proposed changes to the definition of fueled experiment in TS 1.2.9 reflect this. The NRC staff also notes that the plutonium fission chambers requested shall be enclosed and sealed and not open gas-flow fission chambers. Accordingly, the NRC staff finds the requested addition to the LC to allow for 20 grams of plutonium fission chambers to be acceptable.

The NRC staff finds the proposed increases in uranium and plutonium for fueled experiments to be small and similar to that at other facilities that perform fueled experiments. The NRC staff finds that the increases in the SNM do not change the security requirements for the facility. The amount of uranium enriched to greater than 20 percent will still be less than the 1,000-gram limit for a category III facility, the plutonium increase will still be less than the 500-gram limit for a category III facility, and the equation provided in 10 CFR 73.2, "Definitions," which yields the

combined total between U-235 and plutonium to be less than 1,000 grams. Therefore, the NRC staff concludes that the requested changes to the LC to allow for increases in SNM are acceptable.

3.5 Proposed Technical Specification Changes

Changes discussed in this section use the following format: a strikethrough indicates a deletion from the TSs and an underline indicates an addition to the TSs.

3.5.1 Introductory Changes

The proposed change to the TS title page is:

Amendment No. ~~19~~20

This proposed change would change the amendment number given for the TSs from License Amendment No. 19 to License Amendment No. 20 to reflect the requested amendment. The NRC staff finds that this proposed change would be consistent with the issuance of the requested amendment by updating the revision number to reflect that issuance and would not alter the meaning or intent of the TSs. Therefore, the NRC staff concludes that the proposed change to the TS title page is acceptable.

The proposed change to the TS table of contents is:

FIGURES

TABLES

This proposed change would remove figure 3.8-1 and table 3.8-1 from the figures and tables sections of the TS table of contents. In its supplement dated March 13, 2023, the licensee requested that figure 3.8-1 and table 3.8-1 be removed from the lists of figures and tables, due to them being deleted from the TSs. The NRC staff finds that this proposed change would be consistent with the issuance of the requested amendment by updating the TS table of contents to reflect that issuance and would not alter the meaning or intent of the TSs. Therefore, the NRC staff concludes that the proposed change to the TS table of contents is acceptable.

3.5.2 Definition Changes

The proposed change to TS 1.2.9, “Experiment,” is:

> e. **Fueled Experiment**: A fueled experiment is an experiment which ~~contains fissionable material~~ irradiates fissile material. Fueled experiments exclude the following:
> i. Fissile material not subjected to neutron fluence
> ii. Detectors containing fissile material
> iii. Sealed sources
> iv. PULSTAR reactor fuel used in operation of the reactor.

This proposed change would change “contains fissionable material” to “irradiates fissile material.” Also, the proposed change would add four conditions that would be excluded from being a fueled experiment. Specifically, the four conditions that are not fueled experiment are: fissile material not subjected to neutron fluence; detectors containing fissile material; sealed sources; and PULSTAR reactor fuel used in operation of the reactor. This change also includes some administrative changes to line spacing. In its supplement dated March 13, 2023, the licensee stated that the definition of fueled experiment would be clarified to specify the irradiation of fissile material and exclude other common reactor applications of fissile materials such as detectors. The licensee stated that this change does not affect the approved guidance definition of experiments and only affects fueled experiments. In its supplement dated June 20, 2023, the licensee stated that line spacing changes were proposed to make definitions 1.2.7 through 1.2.10 fit on TS page 2. The NRC staff finds that clarifying the difference between reactor operational components and specific fueled experiments in the reactor or that have been in the reactor is acceptable. The NRC staff also finds that the administrative changes to the line spacing would not alter the meaning or intent of the TSs. Therefore, the NRC staff concludes that the proposed changes are acceptable.

3.5.3 Limiting Conditions for Operation Changes

The proposed changes to TS 3.5, “Radiation Monitoring Equipment,” are:

> Applicability
>
> This specification applies to the availability of radiation monitoring equipment which must be opera~~ble~~ting during reactor operation.

The proposed change would replace the word “operable” with the word “operating” in the applicability section of TS 3.5. In its supplement dated June 20, 2023, the licensee stated that the proposed change would require the radiation monitors to be operating during reactor operation. The NRC staff finds that requiring the radiation monitors to be operating (i.e., performing their intended function) would be an increase in safety from the current requirement of operable (i.e., capable of performing their intended function). Therefore, the NRC staff concludes that the proposed change is acceptable.

Specification

The reactor or vented fueled experiment shall not be operated nor shall irradiated fuel or irradiated fueled experiments that are not contained in a properly sealed and approved shipping container be moved within the reactor building unless the radiation monitoring equipment listed below and in Table 3.5-1 is operating~~ble~~. (1)(2)(3)(7)

…

b. Stack p~~P~~articulate and stack gas building exhaust monitors continuously sampling air in the facility exhaust stack with their setpoints as listed in Table 3.5-1.(1)(3)(4)

The proposed changes in the specification section of TS 3.5 would require radiation monitoring for: vented fueled experiments if they are operating, and the movement of irradiated fuel and fueled experiments within the reactor building. The proposed changes would add the word "stack" to the name of the detectors. The proposed changes would require the radiation monitors specified in TS table 3.5-1 to be operating. The proposed changes would also add a provision that if the reactor fuel or fueled experiments are in an approved and sealed shipping container, then TS 3.5 would not apply.

In its supplement dated June 20, 2023, the licensee stated that the proposed changes would require radiation monitoring for vented fueled experiments if the experiment is in operation. In its supplement dated March 13, 2023, which was updated on June 20, 2023, the licensee stated that having these radiation monitors operating ensures that during an accident scenario, the confinement and other emergency actions will automatically occur. The licensee also stated that the proposed name change for the detectors would provide clarity as to which particulate and gas exhaust monitors are required. The licensee stated that the proposed exception for moving irradiated fuel and fueled experiments that are within an approved shipping container is consistent with the guidance in ANSI/ANS-15.1-2007.

The NRC staff finds requiring the radiation monitors to be operating as described in TS table 3.5-1 for irradiated fuel and fueled experiments to be moved within the reactor building to be an increase in safety. The NRC staff also finds that requiring the radiation monitors to be operating as described in TS table 3.5-1 when a vented fueled experiment is operating ensures that the fission gases would still be monitored even after reactor shutdown. This change would allow for fast response time and automatic actions that would reduce the dose to workers and the public in the event of an accident.

For the proposed change for fueled experiments and/or reactor fuel that is in an approved, sealed container, the NRC staff finds that this is an approved practice at other research reactor facilities. The NRC staff also finds that this practice is consistent with the guidance in ANSI/ANS-15.1-2007, section 3.4.1, "Operations that require containment or confinement."

Based on the above, the NRC staff concludes that the proposed changes are acceptable.

Specification

d. Vented fueled experiment exhaust gas radiation monitor continuously monitoring the experiment exhaust gas.(7)

e. Vented fueled experiment flow rate monitor continuously monitoring the experiment exhaust gas flow.(7)

The licensee proposed to add specifications d and e, which would require vented fueled experiment exhaust gas to be continuously monitored for radiation and gas flow. These radiation monitors are only for gaseous effluents since there will be filters installed before the detectors. However, the stack detectors will be able to detect particulates if the particulates penetrate the filters in the vented fueled experiment line. In its supplement dated March 13, 2023, the licensee stated that these requirements would specifically ensure that the rate of release at the experiment is monitored at known conditions (flow rate). The licensee also stated that these monitors would ensure operational conditions are known and would isolate any potential experimental impact on the reactor settings.

In the calculated release results in sections 3.1-3.3 of this SE, no credit was given to these monitors during the calculated events, which resulted in low doses to workers and the public. The NRC staff expects that setpoints for the vented fueled experiment radiation monitor would be based on the known conditions and set as appropriate for particular experiments to ensure that the experiments operate as expected, consistent with typical practice. The NRC staff finds that requiring the flow rate and radiation monitors will increase safety, due to the reactor operators knowing the parameters during operation. Therefore, the NRC staff concludes that the proposed changes are acceptable.

Footnotes

(2) The Over-the-Pool may be bypassed for less than two minutes during return of a pneumatic capsule from the core to the unloading station or five minutes during removal of experiments from the reactor pool. Refer to SAR Section 5.

The proposed change would move footnote two from TS page 19 to TS page 20. In its supplement dated March 13, 2023, the licensee stated that the proposed change is for formatting purposes.

The NRC staff finds that this proposed change would not alter the meaning or intent of the TSs; therefore, the NRC staff concludes that the proposed change is acceptable.

(7) Monitors for vented fueled experiments are only required to be operating while the experiment is in operation.

The proposed change would add footnote seven, which would require radiation monitors for vented fueled experiments to be operating when the fueled experiment is in operation. In its supplement dated March 13, 2023, the licensee stated that by adding this footnote, the reactor could operate without radiation or flow monitors for the vented fueled experiments when there are no vented fueled experiments operating or installed. The licensee also stated that the radiation and flow monitors would be required when the reactor is shutdown so long as the experiment is still in operation. If gas is still flowing through the vented fueled experiment, then the experiment is considered operating.

NUREG-1537, Part 1, appendix 14.1, “Format and Content of Technical Specifications for Non-Power Reactors,” section 3.7.1(2), “Fission Product Monitors,” states that fission product monitors for fueled experiments should be included with fission product monitors for the reactor fuel and section 3.3(5), “Detection of Fission Product Activity,” states that the fission product monitors should be strategically located in a ventilation duct. However, if there are no vented fueled experiments being performed or installed, then there is no need for a fission product monitor to detect the release of fission products from the experiment. The NRC staff finds that not requiring the radiation and flow monitors when there are no vented fueled experiments installed and operating is consistent with the guidance in NUREG-1537, Part 1, appendix 14.1. Therefore, the NRC staff concludes that the proposed change is acceptable.

The proposed changes to TS 3.6, “Confinement and Main HVAC [Heating, Ventilation, and Air Conditioning] Systems,” are:

> Specification
>
> The reactor shall not be operated, nor shall irradiated fuel or irradiated fueled experiments that are not contained in a properly sealed and approved shipping container be moved within the ~~pool area,~~ reactor building unless the flowing equipment is operable, and conditions met:

The proposed change would add a condition for irradiated fuel or irradiated fueled experiments movement in an approved sealed shipping container within the reactor building. In its supplement dated March 13, 2023, the licensee stated that this change would provide additional conditions for the operability of confinement and ventilation systems to cover fueled experiment movement and to broaden the scope of the movement from just the reactor pool to the reactor building.

NUREG-1537, Part 1, appendix 14.1, section 3.4, “Containment or Confinement,” states that the confinement system should be operable during times specified in ANSI/ANS-15.1-2007, section 3.4.1, which states that movement of irradiated fuel or fueled experiments with significant fission product inventory outside of containers, systems, or storage areas requires confinement. The NRC staff finds that the proposed change to TS 3.6 to require confinement when moving irradiated fuel or irradiated fueled experiments within the reactor building is consistent with the guidance in NUREG-1537 and, therefore, the NRC staff concludes that the change is acceptable.

> Footnotes
>
> (7) When the radiation levels reach the alarm setpoint on any single area, or stack exhaust monitor, listed in Table 3.6~~5~~5-1, the building will be automatically placed in confinement as described in SAR Section 5.

The proposed change would correct the reference to TS Table 3.6-1 so that it refers to the applicable table, which is TS Table 3.5-1. In its supplement dated March 13, 2023, the licensee stated that this proposed change would fix a typographical error so that the footnote refers to the table that contains the radiation monitoring equipment.

The NRC staff finds that this proposed change appropriately corrects a typographical error and would not alter the meaning or intent of the TSs; therefore, the NRC staff concludes that this change is acceptable.

The proposed changes to TS 3.8, “Operations with Fueled Experiments,” are:

> a. The ~~mass,~~ fission rate for fueled experiments is limited to $2x10^9$ fissions/sec ~~and power are limited as indicated in Figure 3.8.1 and Table 3.8.1~~.

The proposed change to TS 3.8, specification a, would limit the fission rate for fueled experiments to $2x10^9$ fissions per second and remove the references to figure 3.8.1 and table 3.8.1. In its supplement dated March 13, 2023, the licensee stated that by defining a maximum fission rate, the sample mass and neutron flux can change if the maximum fission rate does not exceed $2x10^9$ fissions per second.

In section 3.3, “NRC Staff Confirmatory Calculations,” of this SE, the NRC staff calculated exposure doses to members of the public and to workers, using the fission rate of $2x10^9$ fissions per second. The NRC staff finds that the doses calculated for accident and routine releases are below 10 CFR Part 20 regulatory limits. Therefore, the NRC staff concludes that this proposed change is acceptable.

> ~~b. The reactor shall not be operated with a fueled experiment unless the ventilation system is operated in the confinement mode.~~

The proposed change to TS 3.8, specification b, would remove the requirement that fueled experiments must be performed with the reactor building in the confinement ventilation mode. In its supplement dated March 13, 2023, the licensee stated that the requirement to operate in the confinement mode is not needed to ensure that the dose to the public is within acceptable limits. The licensee also stated that operating the reactor building in the confinement mode limits the number of emergency systems in place if an accident were to occur.

The guidance in NUREG-1537, Part 1, appendix 14.1, section 3.4 states that the confinement system should be operable during times specified in ANSI/ANS-15.1-2007, section 3.4.1. Section 3.4.1 of ANSI/ANS-15.1-2007 states that only movement of irradiated fuel or fueled experiments with significant fission product inventory outside of containers, systems, or storage areas requires confinement.

The NRC staff finds that the proposed change is consistent with the guidance in NUREG-1537, Part 1, appendix 14.1, and ANSI/ANS-15.1-2007. The NRC staff also finds that fueled experiment operation will be under the envelope of reactor operation, which requires confinement systems to be operable. Therefore, the NRC staff concludes that the deletion of TS 3.8, specification b, is acceptable.

> ~~c. Specification 3.2 pertaining to reactivity shall be met.~~

The proposed change to TS 3.8, specification c, would remove the requirement. In its supplement dated March 13, 2023, the licensee stated that TS 3.2, “Reactivity,” provides the maximum experiment worths and that removing TS 3.8, specification c, would remove redundancy. The NRC staff finds that the deletion of TS 3.8, specification c, would not alter the meaning or intent of the TSs and would only remove a redundant requirement. Therefore, the NRC staff concludes that the proposed change is acceptable.

> ~~d.~~b. Specification 3.7 pertaining to reactor experiments shall be met with the exception that encapsulation is not required for vented fueled experiments, and vented fueled experiments may allow for the release of gaseous airborne activity.

Vented fueled experiments shall be designed to prevent interaction with reactor components or pool water.

The proposed change to TS 3.8, specification d, would remove the requirement for encapsulation for vented fueled experiments. Also, the proposed change would allow for vented fueled experiments to release gaseous airborne activity. The proposed change also adds the requirement for vented fueled experiments to be designed to prevent interaction with reactor components or pool water. Finally, the proposed change would renumber the specification from specification d to specification b. In its supplement dated March 13, 2023, the licensee stated that based on its analysis, all potential releases would produce doses within the 10 CFR Part 20 annual dose constraints. The current restrictions that require the encapsulation of all experiments would be broadened to allow for vented fueled experiments while still maintaining all other requirements for experiments at the reactor. The licensee also stated that adding the requirement to ensure that vented fueled experiments are designed to prevent interaction with reactor components or pool water is meant to ensure reactor component and pool water safety even though vented fueled experiments are not encapsulated. In its supplement dated June 20, 2023, the licensee stated that vented fueled experiments are restricted to only allow for gaseous airborne activity and not particulate releases, further ensuring that doses are kept minimal.

Based on its confirmatory calculation, the NRC staff finds that the expected doses, which are conservatively calculated, are small and pose little risk to the public or workers. The NRC staff also finds that the proposed change helps ensure that vented fueled experiments maintain the safety basis of having the experiment contained and not be reactive to the reactor components or pool water. The NRC staff finds that the proposed change to renumber the specification from specification d to specification b would not change the meaning or intent of the TSs and appropriately reflects the proposed deletions of specifications b and c. Therefore, the NRC staff concludes that the proposed change is acceptable.

~~e. Specification 6.5 pertaining to the review of experiments shall be met.~~

The licensee proposed to delete TS 3.8, specification e. In its supplement dated March 13, 2023, the licensee stated that TS 6.2.3, “RSC [Radiation Safety Committee] and RSAC [Reactor Safety and Audit Committee] Review and Approval Function,” and TS 6.5, “Review of Experiments,” require the review of experiments and that, therefore, TS 3.8, specification e, is redundant. The NRC staff finds that TS 6.2.3 and TS 6.5 require the review of experiments and that TS 3.8, specification e, is redundant and its deletion would not alter the meaning or intent of the TSs. Therefore, the NRC staff concludes that the proposed change is acceptable.

~~Each type of fueled experiment shall be classified as new (untired) experiment with a documented review. The documented review shall include the following items:~~

c. Each type of fueled experiment shall meet the following items:

The licensee proposed to delete the provision in TS 3.8 for special review requirements for fueled experiments that require documented reviews and new types of fueled experiments classified as a new, untried experiment and to renumber the specification to specification c. In its supplement dated March 13, 2023, the licensee stated that since fueled experiments are bounded by the fission rate in proposed TS 3.8, specification a, potential releases would be

minimal. The licensee also stated that the fueled experiments should be treated as regular experiments with no special treatment since the potential releases would be small.

The NRC staff finds that the proposed change is consistent with the guidance in NUREG-1537, Part 2, chapter 10, “Experimental Facilities and Utilization,” RG 2.2, and ANSI/ANS-15.1-2007, section 6.5, “Experiments review and approval,” where there are no special requirements for fueled experiments to have additional reviews beyond those for regular experiments that go into the reactor. The NRC staff also finds that the proposed change to renumber the specification would not change the meaning or intent of the TSs and appropriately reflects the other proposed changes to TS 3.8. Therefore, the NRC staff concludes that the proposed change is acceptable.

> i. Meeting license requirements for receipt, use, and storage of ~~fissionable~~ fissile material.

The licensee proposed to replace the word “fissionable” with “fissile.” In its supplement dated March 13, 2023, the licensee stated that this change reflects the definition of fueled experiment in TS 1.2.9.

The NRC staff finds that the proposed change from “fissionable” to “fissile” accurately reflects the changes in the definition of fueled experiment and the types of materials in the license. Therefore, the NRC staff concludes that the proposed change is acceptable.

> ii. Physical form shall be solid or liquid.

The proposed change would add the requirement that fueled experiments must be in the physical form of solid or liquid. In its supplement dated March 13, 2023, the licensee stated that this requirement would restrict the use of gaseous fueled experiments in the reactor.

The NRC staff finds that the proposed change would limit the physical forms of the fueled experiments to only be solids or liquids to be more restrictive than current TS 3.7, “Limitations of Experiments.” The NRC staff finds that this proposed change would limit the licensee from performing experiments with gaseous fuel materials and that restricting gaseous fueled experiments would be an increase in safety due to the potential for accidental release. Therefore, the NRC staff concludes that the proposed change is acceptable.

> ~~ii~~iii. Limiting the thermal power generated from the fissile material for experiments within the pool water to ensure that the surface temperature of the experiment does not exceed the saturation temperature of the reactor pool water.

The proposed change would specify that only fueled experiments in the reactor pool cannot exceed the saturation temperature of the reactor pool water and would renumber the specification from ii. to iii. In its supplement dated March 13, 2023, the licensee stated that the basis of this change is that the pool water must not boil. The licensee stated that limiting the thermal power of the fueled experiment in the reactor pool will prevent the pool water from boiling.

The NRC staff finds that the proposed change is consistent with the guidance in RG 2.2, which states that the surface temperature of which bounds or supports any experiments should not exceed the saturation temperature of the liquid reactor coolant at any point of the mutual

contact. The NRC staff also finds that the proposed change to renumber the specification would not change the meaning or intent of the TSs and appropriately reflects the other proposed changes to TS 3.8. Therefore, the NRC staff concludes that the proposed change is acceptable.

> ~~iii.~~iv. Radiation monitoring for detection of released fission products at the exhaust of vented fueled experiments.

The proposed change would specify that the radiation monitors for fission products will be located at the exhaust of the vented fueled experiments and would renumber the specification from iii to iv. In its supplement dated March 13, 2023, the licensee stated that this proposed change would provide additional radiation monitoring at the exhaust of vented fueled experiments and notification of any unusual activities at the experiment location.

The NRC staff finds that the proposed change to require radiation monitoring of the exhaust for vented fueled experiments is consistent with the guidance in NUREG-1537, Part 1, appendix 14.1, section 3.7.1, “Monitoring Systems,” subpart 2, “Fission Product Monitors,” which states that the release of fission products from fueled experiments should be included as requiring radiation monitors. The NRC staff also finds that the proposed change to renumber the specification would not change the meaning or intent of the TSs and appropriately reflects the other proposed changes to TS 3.8. Therefore, the NRC staff concludes that the proposed change is acceptable.

> ~~iv. Design criteria related to meeting conditions given in Specification 3.2 and 3.7.~~

The proposed change would delete TS 3.8, specification c, subpart iv. In its supplement dated March 13, 2023, the licensee stated that experiment requirements are in TS 3.2 and TS 3.7 and that, therefore, deleting this provision would avoid redundancy.

The NRC staff finds that the deletion of TS 3.8, specification c, subpart iv., would not alter the meaning or intent of the TSs due to the specification being redundant to the requirements in TS 3.2 and TS 3.7. Therefore, the NRC staff concludes that the proposed change is acceptable.

> ~~f.~~d. Credible failure of any fueled experiment shall not result in releases or exposures in excess of 10 percent of the annual limits established in 10 CFR Part 20.

The proposed change would renumber TS 3.8, specification f, as specification d. The NRC staff finds that this proposed change would not change the meaning or intent of the TSs and appropriately reflects the other proposed changes to TS 3.8. Therefore, the NRC staff concludes that the proposed change is acceptable.

Figure 3.8-1 Removal

The proposed change would delete TS 3.8, figure 3.8-1. In its supplement dated March 13, 2023, the licensee stated that removing TS 3.8, figure 3.8-1 is necessary because the changes to TS 3.8 no longer require the information in that figure. The NRC staff finds that the proposed TS 3.8, specification a., has a fission rate limit, and that, therefore, TS figure 3.8-1 is not needed to guide the licensee in determining fueled experiment parameters for irradiation. The change would leave the page blank. The NRC staff finds that the removal of this figure would aid with clarity since fission rate is the fixed parameter, which is not shown on the figure

and that this change appropriately reflects the other proposed changes to the TSs. Therefore, the NRC staff concludes that the proposed change is acceptable.

Table 3.8-1 Removal

The proposed change would delete TS 3.8, table 3.8-1. In its supplement dated March 13, 2023, the licensee stated that removing TS 3.8, table 3.8-1 is necessary because the changes to TS 3.8 no longer require the information in that table. The NRC staff finds that proposed TS 3.8, specification a., has a fission rate limit, and that, therefore, TS table 3.8-1 is not needed to guide the licensee in determining fueled experiment parameters for irradiation. The change would leave the page blank. The NRC staff finds that the removal of this table would aid with clarity since there will be a maximum fission rate which will allow flexibility in the neutron flux and sample mass outside of what table 3.8-1 shows and that this change appropriately reflects the other proposed changes to the TSs. Therefore, the NRC staff concludes that the proposed change is acceptable.

3.5.4 Surveillance Requirements Changes

The proposed changes to TS 4.4, “Radiation Monitoring Equipment,” are:

> **Applicability**
>
> This specification applies to the surveillance requirements for the area and stack effluent radiation monitoring and vented fueled experiment exhaust gas radiation and flow monitoring equipment.

The proposed change would add vented fueled experiment exhaust gas and flow monitoring equipment to the applicability section. In its supplement dated March 13, 2023, the licensee stated that the applicability section needs to be updated to include the new conditions for the vented fueled experiment exhaust gas radiation and flow monitoring equipment when the experiment is installed in the reactor.

The NRC staff finds that this addition to the applicability is necessary since the proposed changes to this specification are outside the bounds of the current applicability section of TS 4.4 and that this change appropriately reflects the other proposed changes to the TSs. Therefore, the NRC staff concludes that the proposed change is acceptable.

> **Specification**
>
> a. ~~T~~Channel calibration of the area and stack monitoring systems shall be ~~calibrated~~ performed annually but at internals not to exceed fifteen (15) months or after replacement, repair, or modification of the monitoring system.

The proposed change to TS 4.4, specification a, would reword the specification to specifically state channel calibration. The proposed change would also add a requirement that a channel calibration be performed if the channel is replaced, repaired, or is modified. Inn its supplement dated March 13, 2023, the licensee stated that the proposed change stipulates that a channel calibration will be performed so that the whole channel will be calibrated. In its supplement dated June 20, 2023, the licensee stated that the proposed change to calibrate the monitoring systems after replacement, repair, or modification is consistent with the guidance in

ANSI/ANS-15.1-2007, section 4, “Surveillance requirements,” for surveillance testing of the TS-required systems.

The NRC staff finds that the proposed change would not alter the meaning or intent of the specification and would add clarity. The NRC staff finds that the proposed change to require a channel calibration after the channel is replaced, repaired, or modified is consistent with the guidance in NUREG-1537, Part 1, appendix 14.1, section 4, “Surveillance Requirements,” and ANS/ANSI-15.1-2007, section 4. Therefore, the NRC staff concludes that the proposed change is acceptable.

b. The setpoints <u>of the area and stack monitoring systems</u> shall be verified weekly, but at intervals not to exceed ten (10) days.

The proposed change to TS 4.4, specification b, would add a statement specifying that the setpoints of the area and stack monitors shall be verified. In its supplement dated March 13, 2023, the licensee stated that the change is to specify that the systems’ setpoints should be verified.

The NRC staff finds that the proposed change would not alter the meaning or the intent of the specification and would add clarity. Therefore, the NRC staff concludes that the proposed change is acceptable.

<u>c. Channel calibration of the vented fueled experiments exhaust gas radiation and flow monitors shall be performed prior to initial operation of the experiment and annually, not to exceed fifteen (15) months, thereafter while the experiment is installed in the reactor or after replacement, repair, or modification of the monitoring system(s).</u>

The proposed change to TS 4.4 would add specification c, which would add a requirement that the vented fueled experiments exhaust gas radiation and flow monitors are to be channel calibrated prior to the first operation of the experiment and then annually, with a grace period up to 15 months, thereafter, while the vented fueled experiment is in the reactor. The proposed change would also add a requirement that a channel calibration be performed if the channel is replaced, repaired, or modified. In its supplement dated March 13, 2023, the licensee stated that the proposed change would ensure operability prior to the operation of the experiment and then maintain the calibration of the radiation and flow monitors annually in accordance with similar systems. In its supplement dated June 20, 2023, the licensee stated that the proposed change to calibrate the monitoring systems after replacement, repair, or modification would be consistent with the guidance in ANSI/ANS-15.1-2007, section 4 for surveillance testing of TS-required systems.

The NRC staff finds that the proposed TS is consistent with the calibration guidance for radiation monitoring in ANSI/ANS-15.1-2007, section 4.7, “Radiation monitoring systems and effluents,” and NUREG-1537, Part 1, appendix 14.1, section 4.7.1, “Monitoring Systems,” for having an annual calibration when the vented fueled experiment is installed and a calibration when the experiment is first initiated. The NRC staff finds that the proposed change that would require a channel calibration after the channel is replaced, repaired, or modified is consistent with the guidance in NUREG-1537, Part 1, appendix 14.1, section 4 and ANS/ANSI-15.1-2007, section 4. Therefore, the NRC staff concludes that the change is acceptable.

d. The setpoints of the vented fueled exhaust gas radiation and flow monitors shall be verified weekly, but at intervals not to exceed ten (10) days if the vented fueled experiment is installed in the reactor.

The proposed change to TS 4.4 would add specification d, which would require the verification of setpoints on the vented fueled experiment gas radiation and flow monitors weekly, with a grace period up to 10 days. In its supplement dated March 13, 2023, the licensee stated that the setpoints need to be checked if the experiment is in operation.

The NRC staff finds that the proposed specification is consistent with the TS 4.0 surveillances, which require weekly checks on equipment setpoints. The NRC staff also finds that the proposed change is more restrictive than the guidance in NUREG-1537, Part 1, appendix 14.1 and ANSI/ANS-15.1-2007, which do not require licensees to check setpoints on radiation or flow monitoring equipment. Therefore, the NRC staff concludes that the proposed change acceptable.

e. Channel checks shall be performed for the following:
   i. Area and stack radiation monitors prior to first start of reactor operation of the day.
   ii. Vented fueled experiment exhaust gas radiation monitor prior to first start of operation of the experiment of the day.
   iii. Vented fueled experiment flow rate monitor prior to first start of operation of the experiment of the day.

The proposed change to TS 4.4 would add specification e, which would require channel checks on the following: area and stack radiation monitors, the vented fueled experiment exhaust gas radiation monitor, and the vented fueled experiment flow rate monitor prior to first start of operation of the experiment or reactor, as applicable, of the day. In its supplement dated March 13, 2023, the licensee stated that the channel checks for the area and stack radiation monitors prior to reactor operation were proposed to reflect the recommendations in NUREG-1537, Part 1, appendix 14.1, section 4.7.1 and ANSI/ANS-15.1-2007, section 4.7.1. The licensee also stated that the channel checks for the vented fueled experiment flow and radiation monitors are only necessary if the experiment is going to be operated.

The NRC staff finds that the proposed specification is consistent with the guidance in NUREG-1537, Part 1 appendix 14.1, section 4.7.1 and ANSI/ANS-15.1-2007, section 4.7.1. Therefore, the NRC staff concludes that the proposed change is acceptable.

f. Channel tests shall be performed monthly, but at intervals not to exceed six (6) weeks, for the following:
   i. Area and stack radiation monitors.
   ii. Vented fueled experiment exhaust gas radiation monitor if the vented fueled experiment is installed in the reactor.
   iii. Vented fueled experiment flow rate monitor if the vented fueled experiment is installed in the reactor.

The proposed change to TS 4.4 would add specification f, which would require monthly channel tests, with a grace period up to 6 weeks, on the following: area and stack radiation monitors, vented fueled experiment exhaust gas radiation monitor if the experiment is installed in the reactor, and vented fueled experiment flow rate monitor if the experiment is installed in the reactor. In its supplement dated March 13, 2023, the licensee stated that the proposed change

would add requirements recommended by NUREG-1537, Part 1, appendix 14.1, section 4.7.1 and ANSI/ANS-15-2007, section 4.7.1.

The NRC staff finds that the proposed change is consistent with the guidance in NUREG-1537, Part 1, appendix 14.1, section 4.7.1 and ANSI/ANS-15.1-2007, section 4.7.1. Therefore, the NRC staff concludes that the proposed change is acceptable.

The licensee also proposed administrative line spacing changes to TS 4.4 which impacted TS 4.5 and TS 4.6. These changes resulted in moving the bases for TS 4.4 from TS page 35 to TS page 36. This change caused the bases and footnotes for TS 4.5 to move from TS page 36 to TS page 37. TS 4.6 was adjusted on TS page 37 to accommodate for TS 4.5 bases on that page. The NRC staff finds that these changes are due to pagination and do not alter the meaning or intent of these TSs. Therefore, the NRC staff concludes that the change is acceptable.

3.7 *Bases Changes*

Pursuant to 10 CFR 50.36(a)(1), each application for an operating license shall include a summary statement of the bases for TSs, other than those covering administrative controls, but these bases do not become part of the TSs. The NRC staff has determined that the licensee has met this requirement because the bases, as amended, were provided and they are consistent with the changes proposed in the LAR.

4.0 ENVIRONMENTAL CONSIDERATION

Pursuant to 10 CFR 51.22, “Criterion for categorical exclusion; identification of licensing and regulatory actions eligible for categorical exclusion or otherwise not requiring environmental review,” paragraph (b), no environmental assessment or environmental impact statement is required for any action within the categories of actions listed in 10 CFR 51.22(c). The Commission has declared these actions to be “categorical exclusions,” as the actions do not individually or cumulatively have a significant effect on the human environment.

4.1 Proposed Changes

The proposed amendment would revise the LCs and TSs to provide a single fission rate limit that applies to all fueled experiments; to allow the licensee to perform fueled experiments with plutonium, in addition to U-235; and to allow the licensee to perform vented fueled experiments.

To determine whether the proposed amendment is subject to the categorical exclusion in 10 CFR 51.22(c)(9), the NRC staff analyzes it against the following criteria:

(i) The amendment or exemption involves no significant hazards consideration [10 CFR 51.22(c)(9)(i)]*;*

Section 50.92 of 10 CFR states that a license amendment involves no significant hazards consideration if operation of the facility, in accordance with the proposed amendment, would not—

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated [10 CFR 50.92(c)(1)];

The proposed changes would allow the irradiation of vented fueled experiments, increase the inventory of SNM, and amend several TSs to ensure the safe operation of fueled experiments, whether vented or encapsulated. These changes would expand the ability of the licensee to perform fueled experiments. The accident that could occur with a fueled experiment is an uncontrolled release of radioactivity. In section 13.1, “Fuel Pin Clad Failure,” of the Safety Evaluation Report for the license renewal of the PULSTAR reactor (ML15124A090), the NRC staff evaluated and found acceptable the uncontrolled release of radioactivity from three fuel pins, which bounds the uncontrolled release of radioactivity from a fueled experiment failure. The proposed changes would not increase the probability of an accident occurring because the proposed changes do not alter any current systems, structures, or components, and add additional radiation and flow monitors for vented fueled experiments. The radiation and flow monitors that would be added can detect issues with the vented fueled experiment and alert workers before an accident occurs. The proposed fueled experiments would not increase the consequence of the accident analyzed due to having a fission rate limit, which would limit the fission product inventory in fueled experiments available to be released in an accident scenario. Therefore, the NRC staff concludes that the proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

(2) *Create the possibility of a new or different kind of accident from any accident previously evaluated* [10 CFR 50.92(c)(2)]*;* or

The proposed changes would allow vented fueled experiments to be performed at the facility. The licensee currently performs encapsulated fueled experiments. The failure mechanism that would result in an accident for vented fueled experiments would be an uncontrolled release of radioactivity. This accident has been previously evaluated in section 13.2, “Failure of Fueled Experiment,” of the license renewal SER, and found to be bounded by the uncontrolled release of radioactivity from the cladding failure of three fuel pins. In addition, the proposed amendment would not introduce any new accident scenarios, transient precursors, failure mechanisms, or limiting single failures, and there would be no adverse effect or challenges to any reactor related safety systems. Therefore, the NRC staff concludes that the proposed changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

(3) *Involve a significant reduction in a margin of safety* [10 CFR 50.92(c)(3)].

The proposed changes would allow the irradiation of vented fueled experiments. The proposed changes do not authorize any changes in the design, function, or operation of systems, structures, and components, or change the authorized steady-state reactor power level. The proposed changes do not alter how safety limits or limiting safety system settings are determined, change the limiting conditions for operation in an adverse way, or affect the reliability of equipment assumed to mitigate accidents in the facility. In addition, the proposed changes do not adversely affect equipment required to safely shut down the reactor and required to maintain it in a safe shutdown condition. Therefore, the NRC staff concludes that the proposed changes do not involve a significant reduction in a margin of safety.

(ii) There is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite [10 CFR 51.22(c)(9)(ii)]*; and*

The proposed changes would allow the irradiation of vented fueled experiments. The proposed changes do not result in a significant change in the types of, or a significant increase in the amounts of, effluents that may be released offsite. During normal operation, a vented fueled experiment will be off-gassing fission products into the reactor ventilation system to be discharged up the stack. Without crediting any filtration that will be installed, the licensee's routine release calculations show that the annual increase in dose from vented irradiation would be 0.003 mrem, as seen in table 3.1 of this SE. The NRC staff calculated a conservative confirmatory estimation of the annual dose due to effluents, which yielded a dose of 3.22 mrem, as seen in table 3.3 of this SE. Even with the conservative confirmatory estimation, the dose would not exceed the ALARA constraint in 10 CFR 20.1101. The licensee plans to operate the vented fueled experiments with filters that are not credited in either calculation and that will further reduce the types and number of effluents released up the stack. Since the estimated release of effluents is so low, there will not be a significant increase in the types or amounts of effluents being released. Therefore, the NRC staff concludes that there is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite from the proposed changes.

(iii) There is no significant increase in individual or cumulative occupational radiation exposure [10 CFR 51.22(c)(9)(iii)]*.*

The proposed changes would allow the irradiation of vented fueled experiments. The vented fueled experiments would be designed to exhaust the fission product gases to the reactor building ventilation system. The exhaust gas would be monitored by radiation and gas flow monitors. The occupational workers would not be exposed to the gases for routine vented fueled experiment operations. In an accident scenario, both the licensee and the NRC staff conservatively calculated that the expected dose to radiation workers is within the annual dose limits of 10 CFR Part 20 for occupational workers. The calculations for worker dose exposure and vented fueled experiment design are discussed in section 3 of this SE. Since an accident scenario would not be a frequent event and since the routine operation of the vented fueled experiments would not expose occupational workers to effluents, the NRC staff concludes that there is no significant increase in individual or cumulative occupational radiation exposure from the proposed changes.

4.2 Conclusion

The amendment changes requirements with respect to the installation or use of facility components located within the restricted area as defined in 10 CFR Part 20 or changes surveillance requirements. The NRC staff has determined that the amendment involves no significant hazards consideration, there is no significant change in the types or significant increase in the amounts of any effluents that may be released offsite, and there is no significant increase in individual or cumulative occupational radiation exposure. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

5.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

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